PAPERWING

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Date school ends for the year: 13th June.

General characteristics

Crew : 2 (pilot and co-pilot acting as flight engineer)
Capacity : 64 (in a high density layout)
Length: 36 m
Wingspan: 60 m
Height : 3 m (6 m when on wheels)
Wing area : due to the blended wing design , the whole aircraft is basically one big wing having 384 square meters (whole aircraft area) an 400 square feet when the sonic wings are uncovered
Baggage : 18 cubic meters
Engines : 1 - 6 meter long modified Rolls Royce Olympus
2 – 4 meter long modified Rolls Royce Trent 800 (with same modifications as Rolls Royce Olympus)
Maximum fuel load : 60 000 kg kerosene and 6 000 compressed hydrogen
Maximum cruising speed : Mach 2.5
Average cruising speed : Mach 1.8
Range : 7 000 km
Fuel consumption : 10 kg kerosene /km + 1 kg Hydrogen /km

Introduction

The project proposes new solutions that will make today's aircraft a more efficient and ecological one. This new aircraft guarantees to be the father of future eco-fuel powered engines. We outfitted the 3 massive Rolls Royce Olympus engines with 3 different noise reduction technologies and we have designed an efficient propulsion system. This plane powers itself electrically using both wind turbines and solar panels. It's made out of carbon fiber and implements the blended wing design for mainstream passenger use. We have tried to improve the form and to use some specific tools in order to increase flight efficiency, to reduce the noise, the emissions and the fuel consumption. We suggested the use of recyclable materials and we tried to construct an aircraft with ecological features and to protect our environment.

1. Shape and aerodynamic properties

1.1 Theory

1.1.1 Aerodynamics

There are, basically, four forces of flight: lift, drag, thrust and weight. Lift force point upward, opposite to the weight. Thrust pushes the plane forward, as drag slows it down. The lift force must be greater than the weight and the thrust more powerful than the drag for the plane to fly.

Air moves over the top and bottom of the wing at different speeds to create lift. The wing itself can have a curved upper surface and flatter lower surface. This forces the air flowing over the top of the wing to move faster. This creates lift. Another way is to use a flat wing and fly at an angle to the wind. Generally, the faster you go, more lift is created. That's why the wings of our airplane have a curved upper surface.

Thrust is created by airplane engines. The thrust must be powerful enough to overcome weight and drag. [1]

It is important to know what the causes that slow down an airplane are. For example, there are several types of drag. When an airplane is flying near or faster than the speed of sound the air flow around the aircraft changes and becomes an additional drag (wave drag). . If the plane is "streamlined" the air will pass around it with less drag, so the form plays an important role in the efficiency of an aircraft (form drag). Friction drag is proportional to viscosity and fortunately, air has a rather low viscosity. When lift is created around a wing, drag is also created (induced drag).

A streamlined shape causes the air to accelerate, so the region of highest pressure is smaller, and more importantly, the streamlined shape cultivates high pressure behind the object that pushes it forward, canceling most of the pressure drag.

We have to ensure that even the smallest things are perfectly aligned with the airflow, so that we will reduce part of the drag. [2]

Conclusions:

One way to reduce induced drag (while maintaining the same amount of lift) is to have a longer wing span and to fly faster.

One way to minimize friction drag is to minimize the total wetted area (i.e. the total area that has high-speed air flowing along it).

One way to reduce form drag is to minimize separation, by making everything streamlined. One solution is to utilize the model of a blended-wing.

1.1.2. Aspect Ratio

The aspect-ratio is a very important indicator of the wing's performance and gives the stability of the airplane. The wingspan is a crucial component of the performance as an airplane derives in lift from a roughly cylindrical tube of air that is affected by the craft as it moves, and the diameter of that cylindrical tube is equal to the wingspan. Thus a large wingspan is working on a large cylinder of air and a small wingspan in working on a small cylinder of air.

For insuring high performances of flight, the airplane must have efficient ability at both low speed and supersonic speed. That means that the propulsive system must be intended for the whole scale of flight speeds possible.

$$AR = \frac{b^2}{S}$$

Where b is the wing span and S is the wing area.

One way to reduce induced drag is to increase the aspect ratio of the lifting surface. A high aspect ratio wing will have an important roll in maneuverability as will have a lower roll rate than one of low aspect ratio, because in a high-aspect-ratio wing, an equal amount of wing movement due to aileron deflection will result in less rolling action on the fuselage due to the greater length between the aileron and the fuselage. A higher aspect ratio wing will also have a higher moment of inertia to overcome. [8]

As practicality is important a low aspect ratios have a greater useful internal volume.

When we refer to subsonic flow, the most significant component of drag is the induced drag, which is a function of the circular tube of air affected but the wings passage. However, as the flow becomes supersonic, the shock wave first generated along the wing's upper surface causes a huge drag on the aircraft that is not benefic, and this drag is proportional to the length of the wing. The longer the wing the longer the shock wave will become. Thus a long wing, valuable at low speeds, becomes a detriment at transonic speeds. A solution to this problem can be a moveable wing as we intend to use for "paperwing".

Conclusion: We intend to design an airplane that has an efficient form and a *practical* aspect ratio in both supersonic and subsonic speeds. Thus this we've created a aircraft that uses winglets at subsonic flow for safety and we modify the surface at super sonic flow in order to create delta form that is perfect for high speeds.

1.2 Aerodynamic form

We suggest a combination between the two structures: blended-wing and delta-wing in order to obtain an efficient airplane both at subsonic speed, and supersonic speed. Our model is also based on the variable geometry of the aircraft.

We decided to vary the aircraft's geometry when changing from subsonic to supersonic speeds and vice versa so as to improve aerodynamic efficiency and save propulsion energy. [19]

For supersonic flight, we will try to modify the airplane's geometry, so we will form a delta-wing by extending (with a hydraulic system) a pair of retractable wings And which would extend out of their compartments just before the sonic boom occurs .These compartments would also divide passenger quarters from fuel compartments .

The primary aerodynamic input to the wing's cross sectional shape is the need to keep the air flowing smoothly over the entire surface for the most efficient operation. In particular, there is a requirement to prevent the low-pressure gradient that accelerates the air down the back of the wing becoming too great and effectively "sucking" the air off the surface of the wing. If this happens the wing surface from that point backwards becomes substantially ineffective. [25]

1.3 The advantages provided by our chosen wing design

1.3.1 Blended Wing

The main idea is to integrate the engine, the wings and the body into a single surface. This would reduce fuel burn and harmful emissions.

Blended wing/body aircraft have a flattened and airfoil shaped body, which produces most of the lift to keep itself aloft, and distinct and separate wing structures, though the wings are smoothly blended in with the body.

There are several big advantages to the blended wing design, the most important being the lift to drag ratio which is expected to increase (studies reveal that it can increase with almost 50%), overall weight reduced by 25% so the fuel consumption in reduced as well, high body rigidity which reduces turbulence and creates less stress on the air frame.

Advantages:
- Improved fuel economy
- Reduced noise impact (if the engines are placed above the wings)
- Improved structural weight
- Efficient high-lift wings and a wide airfoil-shaped body
- Lower operating cost
- Increased aerodynamic performance
- Increased safety and aircraft size
- Minimize the length of landing take-off
- Substantial interior volume
- Simplicity of manufacture

Disadvantages:
- Low or absent possibility of side windows for passenger compartments
- Weight increase and structural complexity [3]

The advantages of a blended wing in reducing noise emissions

As turbulent airflow, generated by irregular surfaces, causes noise, the airframe must be as smooth as possible. The aerofoil shape of the body means that it also contributes to the aircraft's lift, meaning it can make a slower approach on landing, again reducing noise. The improved lift also means that the plane can do away with flaps on the wings, which are a major source of airframe noise on conventional aircraft. Because the design does not need a tail, used to provide additional lift and stability on conventional craft, it also cuts down on turbulent airflow and noise from the back of the plane. [13]

1.3.2 Delta Wing

The primary advantage of the delta wing design is that the wing's leading edge remains behind the shock wave generated by the nose of the aircraft when flying at supersonic speeds, which is an improvement on traditional wing designs. While this is also true of highly swept wings, the delta's plan form carries across the entire aircraft, allowing it to be built much more strongly than a swept wing, where the spar meets the fuselage far in front of the center of gravity. Generally a delta will be stronger than a similar swept wing, as well as having much more internal volume for fuel and other storage.

Another advantage is that as the angle of attack increases the leading edge of the wing generates a vortex which remains attached to the upper surface of the wing, giving the delta a very high stall angle. A normal wing built for high speed use is typically dangerous at low speeds, but in this regime the delta changes over to a mode of lift based on the vortex it generates. The disadvantages, especially marked in the older tailless delta designs, are a loss of total available lift caused by turning up the wing trailing edge or the control surfaces (as required to achieve a sufficient stability) and the high induced drag of this low-aspect ratio type of wing.

Additional advantages of the delta wing are simplicity of manufacture, strength, and substantial interior volume for fuel or other equipment, big wing surface, reduced drag at supersonic speed. One disadvantage of this model is that it isn’t very stable at low speeds. Because the delta wing is simple, it can be made very robust (even if it is quite thin), and it is easy and relatively inexpensive to build.[24]

1.3.3 Winglet

A winglet is a vertical extension of the wing tips. The wingtip vortex, which rotates around from below the wing, strikes the cambered surface of the winglet, generating a force that angles inward and slightly forward. The winglet converts some of the otherwise-wasted energy in the wingtip vortex to an apparent thrust. At the first sight, this is a small contribution, but it can be worthwhile in time.

Another benefit of winglets is that they reduce the strength of wingtip vortices, which trail behind the plane.

Winglets also increase efficiency by reducing vortex interference with laminar airflow near the tips of the wing, by moving the confluence of low-pressure (over wing) and high-pressure (under wing) air away from the surface of the wing. We will use a winglet with a higher degree of sweep, than the rest of the wing. This will improve fuel efficiency, climb performance and also it will shorten the take off field length. In this case, the effective aspect ratio will be increased.

Winglets are also important in maintaining the stability of the airplane. [23]

1.3.4. Reducing the drag

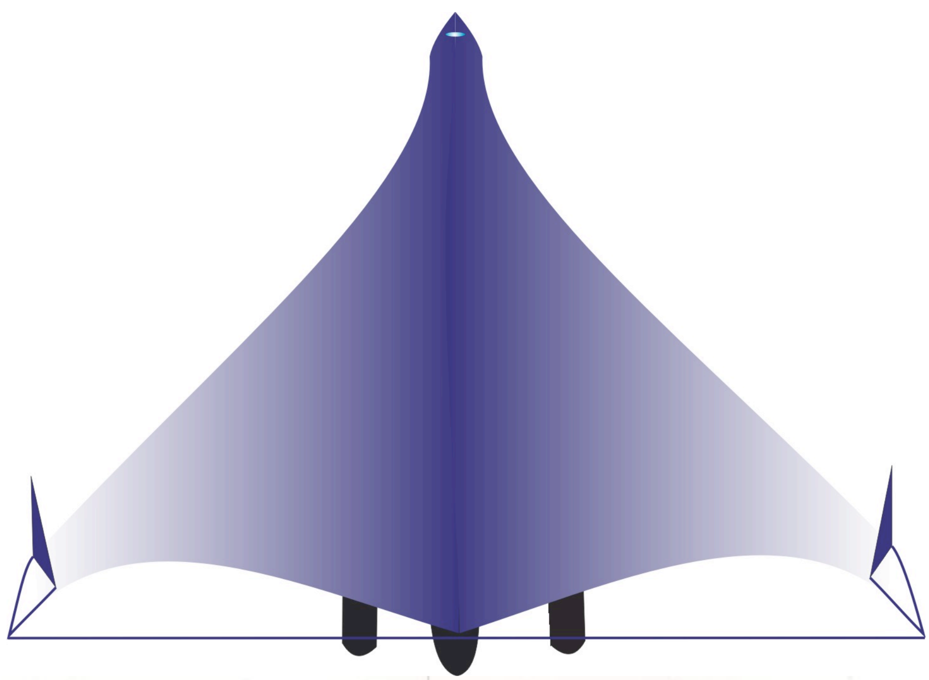
We will also try to reduce drag by creating an airplane model which would fly at supersonic speeds, having longer wingspan and modeled after the blended-wing design. This shape has far greater aerodynamic properties due to the fact that the wings aren’t separated from the main body of the plane, but instead forming a single body.

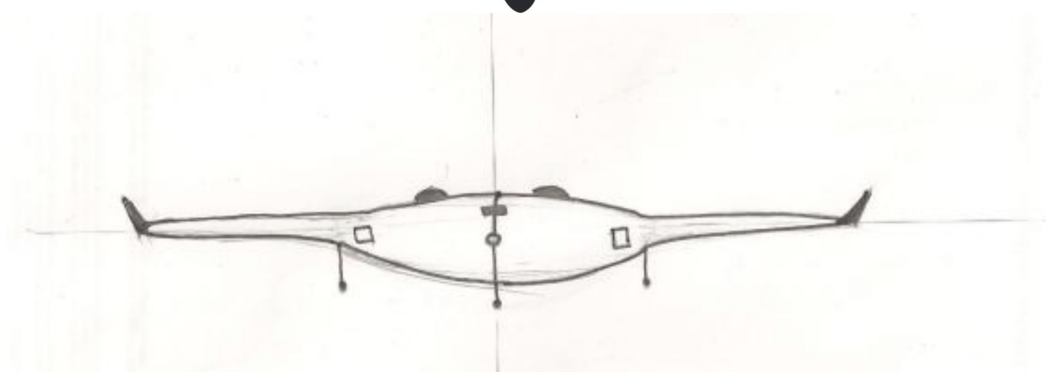
On a wing of finite span, some air flows around the wingtip from the lower surface to the upper surface producing wingtip vortices. The vortices change the speed and direction of the airflow behind the trailing edge, deflecting it downwards, and thus inducing downwash behind the wing. This requires a higher angle of attack to compensate, and tilt the total aerodynamic force rearwards.

The leading and the trailing edges add much to the wing's strength. Making these smooth and fair also contributes to the model's aerodynamic efficiency.

The size of the wing vortices will be much reduced on a longer, thinner wing, so we will try to make a compromise between the length of the wings, the thickness of the wings and the stability of the airplane, in order to reduce drag.

One solution that we propose is to modify the lift distribution by changing the airfoil section near the wingtips. This allows more lift to be generated at the wing root and less towards the wingtip, which causes a reduction in the strength of the wingtip vortices. This increases fuel efficiency, in powered aircraft and it contributes in the environment protection. [4]





2. Engine design

2.1 Modifications made to the Rolls Royce Olympus 301

What we had in mind for an engine was a modified version of the old Rolls Royce Olympus 301. [17]

We say modified version because we intend to double the number of fuels injectors due to the fact that we intend for the “Paperwing” to run on a kerosene-hydrogen mix.

The reason we aren’t opting for hybrid instead of true environmentally friendly aircraft is because we believe a fully hydrogen powered aircraft wouldn’t have any near-future applications (10-20 years from now at best).

Instead we are going to make a “missing link” of aeronautical evolution.

The modification made to the engine will allow for changes to be made in the future, so as to permit their transformation to fully hydrogen powered aircraft.

We believe that by providing this first step to mainstream hydrogen consumption, even for a hybrid, we are truly readying the way for the transition from hydrocarbons to hydrogen.

The modifications mainly consist of the addition of a hydrogen injector formed up as a circular ring situated in between the combustion chamber and the end of the turbojet’s initial compressor.

This would ensure that the kerosene would be ignited not only by the usual pressure created by the compressed air but by the massive energies released by the combustion of hydrogen.

Of course, due to the massive energies released, the turbo-expander would need to be either reinforced or widened at both it’s most narrow point and in it’s widest.

We also suggest that the exhaust panels be elongated so that any energies or waves bounce of the enlarged walls.

These modifications do not , in any way , disagree with the Brayton cycle , but on the contrary , these may actually increase the systems entropy and efficiency .

This model of engine balances the intake and output so that the net effect on the atmosphere is zero. This is one way to reduce the emissions at high altitudes, and also the pollution.

We've decided to coat 90% of the engines surface in a thick layer of a sound converter. This would be placed all over the engines surface except the ventilators and the exhaust. We suggest that we use this technology to transform most of the engines sounds into ultrasounds.[18]

This engine will be placed under enormous forces, pressures and temperatures we suggest a special composite and alloy. [16]

2.2. Materials

The bulk of the material would be based on rhenium diboride combined with different metals or even coated in other metals so as to ensure that it resists high temperatures (this is something to which Rhenium is second only to Tungsten and carbon) , great pressures and if necessary shock . The use of rhenium diboride allows an increase of the temperature at which the engine can be operated and eventually the elimination of the cooling fluids, both resulting in an increase of yield.

We also suggest gold plating on the outside of the combustion chamber due to the fact that it’s a great heat conductor and the transition of heat from the engine to the outside would help cool the engine.

As other alloy elements we suggest ruthenium, aluminum , nickel , titanium , chromium , molybdenum and cobalt.

As an alloy it would behave like a fourth generation alloy but it would be much more resistant.

Being so strong means that rhenium diboride alloys are less likely to conduct sound and might help in our struggle to lower airport noise.

We will use an heterogenous material (different density oils) to cover the engine. This will transform 90% of their sound in ultrasound.

The characteristics of the materials the engine will be made off are: high thermal shock resistance, high hardness, high corrosion resistance, light weight, nonmagnetic and nonconductive properties. Other benefits of using rhenium diboride for the engine are that it increases energy efficiency, productivity and it is compliant with current aircraft standards. [7]

2.3 Propulsion efficiency

The engine is designed to reach supersonic speeds (2 Mach) and it has a high propulsion efficiency due tot our methods to reduce the drag and the loss of energy.

$\eta = \eta_c \eta_p$, η_c -the cycle efficiency η_p - the propulsive efficiency.

We will extract the hydrogen from nature (water), to make the airplane more ecological.

2.4 Fuel system

2.4.1 Center of gravity and center of pressure

There are two groups of fuel tanks, the main group in the wings and fuselage and the trim tanks at the front and rear of the fuselage. The main group of tanks with five tanks in each wing and four tanks in the fuselage automatically maintains the aircraft's centre of gravity in cruise flight. The trim tanks consist of two forward tanks and one rear tank located in the fuselage beneath the vertical tail fin. The trim tanks transfer fuel rearward during aircraft acceleration to supersonic flight and transfer fuel forward during deceleration from supersonic to subsonic flight, thereby maintaining a balance between the centre of gravity of the aircraft and the aerodynamic centre of pressure. The fuel system also acts as a heat sink to maintain thermal stability. [12]

2.4.2 Kerosene and Hydrogen

We have opted for using liquid hydrogen instead of gas because it is easier to store. They will be stored in different chambers because there is always the danger of the 2 might reacting prematurely.

They will be stored under the retractable wings and will be using a series of suction valves to the reaction chamber.

2.5 Air Cooling

The turbine is exposed to the hot gases from the combustion chamber. To prevent the vanes and the blades from melting, cold air is bled from the compression system and used to cool the turbine. The air has to be cooler than the object or surface from which it is expected to remove heat. For a greater efficiency in cooling, we have decided to add fins to the surface of the turbine. A heat sink will form, which will improve the transfer of heat, and cool the engine more efficiently. [20]

2.6 Reducing the sound

2.6.1. Honey Comb Structure

Noise from commercial and military jet aircraft causes environmental problems for communities near airports, obliging airplanes to follow often complex noise-abatement procedures on takeoff and landing. It can also make aircraft interiors excessively loud.

Most sound-deadening materials – such as foams or other cellular materials comprising many small cavities – exploit the fact that acoustic waves resonate through the air on various frequencies. Just as air blowing into a bottle produces resonance at a particular tone, an acoustic wave hitting a cellular surface will resonate in certain-size cavities, thereby dissipating its energy. An automobile muffler, for example, uses a resonance-dependent technique to reduce exhaust noise.

We will use tiny parallel tubes in porous media such as metal or ceramics create a honeycomb-like structure that traps sound regardless of frequency. Instead of resonating, sound waves plunge into the channels and dissipate through a process called viscous shear. Viscous shear involves the interaction of a solid with a gas or other fluid. In this case, a gas – sound waves composed of compressed air – contacts a solid, porous medium, and is weakened by the resulting friction.

The result is acoustic waves don't resonate; they just dissipate. We will construct a prototype from off-the-shelf capillary tubes, which readily forms a low-density, honeycomb-like structure. It requires a material that's light, strong enough to enable the walls between the tubes to be very thin, and yet robust enough to function reliably amid the high-temperature, aggressive environments inside aircraft engines, strength, tolerance of high temperatures and corrosion resistance(maybe a nickel alloy).

This new approach could attenuate aircraft engine noise by up to 30 percent. Micro-honeycomb material could also provide another means to protect the aircraft in critical areas prone to impact from birds or other foreign objects by dissipating the energy of the collision.

2.6.2. Acoustic liners and Muffling Materials

The engines are also mounted deep within the intake ducts, lined with mufflers, to maximize the noise absorption. By embedding the three engines in the aircraft frame, it also reduces drag and therefore noise. Instead of having one large fan, they have three arranged side-by-side. The smaller fans means the noise from each one is easier to absorb with surrounding "acoustic liners", or muffling materials. This material includes fibers retained in compressed form by a material of lower softening temperature than the fibers. When the material is heated by exhaust gases, the material of lower softening temperature is softened allowing the compressed fibers to expand. The fibers may be formed into a knitted fabric retained by a sacrificial thread. An acoustic liner includes a remote panel, a proximate panel and a resonator chamber residing between the panels. A neck with an inlet recessed from the proximate panel establishes communication between the chamber and a fluid stream flowing past the proximate panel. [22]

2.6.3. Trailing edge brushes

When turbulent air moving over the top surface of the wing shoots off the trailing edge it abruptly meets non-turbulent air. The result generates a huge amount of noise. We will construct "trailing edge brushes", a series of long, thin protrusions off the back of the wing. These allow a smoother transition between turbulent and non-turbulent air and could reduce trailing-edge wing noise.

The leading-edge of the wings are slightly drooped. These further help improve the lift of the aircraft, particularly at lower speeds. To cut-down on the amount of noise generated by air whistling through a slat between the main wing body and the leading edge, the gap is covered in a flexible material.

2.6.4 Nozzle Chevron design

Engine modifications included new engine nozzle chevron designs that take into account the air flow and acoustic differences that occur after an engine has been installed on the aircraft. Chevrons are asymmetrical scalloped or serrated edges that reduce both cabin and community noise. [21]

3. Structure

3.1. Materials for overall plane construction

We have decided to make the plane out of carbon fiber reinforced polymers.

This is a very strong material and also very light weight so it wouldn't have any trouble in coping with the challenges of super sonic flight. **.** The heavier an aircraft weighs, the more fuel it burns, so reducing weight is important to aeronautical engineers.

The carbon atoms are bonded together in microscopic crystals that are more or less aligned parallel to the long axis of the fiber. The crystal alignment makes the fiber very strong for its size. Carbon fiber (sometimes combined with other materials like different polymers) has a high strength-to-weight ratio material. The density of carbon fiber is also considerably lower than the density of steel, making it ideal for applications requiring low weight. The most important properties of carbon fiber are: high tensile strength, low weight, and low thermal expansion. Depending on the orientation of the fiber, the carbon fiber composite can be stronger in a certain direction or equally strong in all directions. A small piece can withstand an impact of many tons and still deform minimally. [5]

This choice also follows our "transition theme" due to the fact that we can easily go from carbon-plastic combinations to carbon-carbon like reinforced carbon-carbon. This material has already proven itself in NASA missions.) [6]

3.2. Light panels

We've considered plating the Paperwing in silicon which (molded over the blended wing design) would be made into light cells. The plan is to use the solar cells to power the vehicle's electric motors and subsystems during the day and to use a modified commercial hydrogen–air fuel cell system for use during the night.

We will use a cyanoacrylate glue to help bind the silicon frame over the main carbon fiber body.

We want to use the solar energy in order to replace one of the engines or at least part of the power generated by it. This way, we will use less fuel, lower the operating cost and the airplane will be more ecological.

We will attach photoelectric cells to the airplane's upper airframe. These photoelectric cells will transform the solar energy in electric energy, which will be used to propel the airplane. One cell contains two thin layers made of semi conductor material. Between the two layers, it will appear a difference of electric potential. The electrons will create continuum current. The current will be collected by some electrodes from the semi conductor layers. We will increase the amount of absorbed light by putting an anti-reflective bed. [14]

3.3.Materials for sensors

Obviously the plane will need infrared sensors, radar and communication sensors due both to the fact that it needs to make up for its lack of windows and it also needs places for standard communication devices. We decided to make these openings out of reinforced glass fibers.

3.4.Tip

We have decided to make the plane's nose cone out of rhenium diboride .We have opted for the old Concorde idea of making a droop nose tip which would shorten the runway length to about 500 m. [9]

4. Auxiliary devices

4.1.Wind turbines

We have come up with the idea of harvesting wind power by strategically placing specially designed wind turbines on the airplane.

By "strategically placing" we mean symmetrically placing them on the planes surface so as to avoid off course deviations.

We quickly realized that besides this first difficulty there would be the big problem of whether or not this system would survive the speeds and G forces of Mach 2. So we came up with a design that ensures its functionality.

Air currents drifting along the planes surface would be drawn into orifices placed parallel to the planes trajectory.

These currents turn 2, 8-bladed fans which would always be symmetrically aligned .

These fans then spread out into 2 different shafts.

This is where we introduce our concept.

Instead of being joined with the generator via a gear box, we propose the implementation of a separate room in which the ends of the fans (8-bladed as well) would create a specific-direction wind which would spin the gear box.

This method is similar to the design of the Barret 102's floating barrel design and it makes the wind turbine to function less efficiently but it compensates by being safer. [15]

4.2. Sensors

As we have already stated, the plane will not have any windows. We have decided to implement many different sensors in our design such as: infra-red, proximity sensors, humidity sensors , means of communication with aircraft control centers ,light sensors, acceleration sensors and sensors in the actual optic fiber casing .

All the data will be put forth for analysis and interpreted by a computer's mainframe. In order to avoid human errors we thought an automatic pilot would improve the safety of a flight. A computer will always have more accuracy at landing and taking off but should have the property to avoid barriers during the main flight as humans and insects do. So it should have an automatic rectifier of barriers.

4.3. Hybrid Ice Protection

We will use the hybrid ice protection system for the retractable wings, when the airplane is flying with supersonic speed at high altitudes.

As the airplane flies at a very high altitude (18 000 m), where the temperature is very low, ice can form on the airplane. But roughness affects the aerodynamic performance by altering the boundary layer development. It can also induce early separation resulting in a significant loss of lift. The initial ice formation generates distributed roughness elements on the surface.

We want to create a system in order to develop an alternative to existing high power anti-icing systems, to improve on currently used thermal/mechanical deicing systems, and to provide an effective anti-icing system to aircraft that requires a smooth surface but lack the power budget.

A running-wet anti-ice either electro-thermal or hot gas keeps the airframe free of ice contamination. The runback water freezes downstream of the heated zone where any thermal system would be inefficient as a result of the low surface wetness factor associated with the runback rivulet flow structure. In this hybrid system, a mechanical de-icing system is used at those locations to deflect the airfoil's semi-rigid skin and periodically remove the ice accumulation which results from frozen runback and/or direct water droplet impingement.[10]

This works on the principle of opposing electro-magnetic fields resulting from opposing current flow in adjacent conductors. Unlike systems using the "parting strip" concept, this one does not require a thermal system. The combined sub-systems deliver an efficient and low cost ice protection system. [11]

5. Safety issues

The reduction of accidents is an important problem to resolve**.** The statistics sow that most accidents, almost 80% take place at short time after or before the take off or landing and are a result of human errors. More the a half of the accidents are from human cause and only 7% from the weather as such problems can be prevented.

In addition a big aircraft like the "paperwing" will always offer more safety then a small plane in case of an accident.

Conclusions

We have made some modifications in today's aircraft model that we hope will improve its performance. We have used wind turbines and photoelectric cells to get energy from nature, thus the airplane is more eco-friendly. We have used materials (such as carbon fiber) to reduce its weight and to make it more resistant. The airplane can reach supersonic speeds, but we have also reduced the sound by using trailing edge brushes, acoustic liners, muffling materials and the honey-comb structure. We tried to find the best shape which has great aerodynamic performances both in subsonic and supersonic flight. The blended-wing design that we have used provides a high payload capacity, a better comfort for the passengers and reduces the drag so it also reduces the fuel consumption. The airplane of the future must be safer, more economical, less polluting, so it should take advantage of the progress made in aerodynamics, electronics and engineering.

"All truth is one in this life. May science and religion endeavor here for the steady evolution of mankind .From darkness to light, from narrowness to broadmindedness , from prejudice to tolerance . It is the voice of life which calls us to come and learn."

-Hayes Clock Bell Tower, State University of New York

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